CLAIMS

1. A method for automatically detecting and tracking the contour of a starting image, said starting image being formed by an array of pixels and each pixel having an intensity, being *n* and *m* coordinates of a generic pixel, comprising the steps of:

- filtering said starting image through an absolute central moment *e(n,m)* of the intensity of the pixels of said starting image, wherein said absolute central moment is obtained with the following steps:
  - determining for each *n,m* a local mean calculated on a neighborhood about a pixel of coordinates *n,m* of the starting image, obtaining a first filtered image;
  - determining for each *n,m* a sum of absolute differences between the intensity of the pixel having coordinates *n,m* of the first filtered image and the intensity of all the pixels contained in a neighborhood about said pixel of coordinates *n,m* of either said starting image or a second filtered image derived from said starting image,
  - wherein said sum of absolute differences is split calculating a sum of positive differences, or positive deviation, and a sum of negative differences, or negative deviation.

2. Method according to claim 1, wherein said sum of absolute differences is calculated computing the differences between said first filtered image and said second filtered image, wherein said second filtered image is obtained for each *n,m* from a local mean calculated on a neighborhood about the pixel of coordinates *n,m* of said starting image.

3. Method according to claim 1, wherein said absolute central moment *e(n,m)* is calculated in a generalized way as follows:

$$e(n,m) = w_4(n,m) \otimes \sum \sum_{(k,l)\in\Theta_3} \left|\mu_1(n,m) - \mu_2(n-k,m-l)\right| w_3(k,l) \quad (1)$$

where:

n,m are the coordinates of a pixel of a map *f(n,m)* of said image;

$w_1(n,m)$, $w_2(n,m)$, $w_3(n,m)$ and $w_4(n,m)$ are four weight functions defined on four circular domains Θ_1, Θ_2, Θ_3 and Θ_4, respectively of radius r_1, r_2, r_3 and r_4 and defined as $\Theta_i = \{(k,l) \in I^2 : \sqrt{k^2+l^2} \le r_i\}$;

$\otimes$ is a convolution operator;

$\mu_1(n,m) = \sum \sum_{(k,l)\in\Theta_1} f(n,m) w_1(n,m)$ is a mean value on domain Θ_1 of said map and of said first filtered image;

$\mu_2(n,m) = \sum \sum_{(k,l)\in\Theta_2} f(n-k,m-l) w_2(k,l)$ the mean value on domain Θ_2 of said map and of said second filtered image.

4. Method according to claims 3 and 4, wherein, starting from said absolute generalized central moment, said positive deviation $e_p(n,m)$ and said negative deviation $e_n(n,m)$ are used as further filters, defined as

$$e_p(n,m) = w_4(n,m) \otimes \sum \sum_{(k,l)\in\Theta_{3p}} \left(\mu_1(n,m) - \mu_2(n-k,m-l)\right) w_3(k,l)$$

$$e_n(n,m) = w_4(n,m) \otimes \sum \sum_{(k,l)\in\Theta_{3n}} \left(\mu_1(n,m) - \mu_2(n-k,m-l)\right) w_3(k,l) \quad (7)$$

where domains Θ_{3p} and Θ_{3n} are defined as:

$$\Theta_{3p} = \{(k,l) \in \Theta_3 : \mu_1(n,m) > \mu_2(n-k,m-l)\}$$

$$\Theta_{3n} = \{(k,l) \in \Theta_3 : \mu_1(n,m) < \mu_2(n-k,m-l)\} \quad (8)$$

5. Method according to claim 4, wherein said step of computing the absolute generalized central moment of the intensity of a pixel comprises the steps of:

– defining said circular domains Θ_1, Θ_2, Θ_3 and Θ_4, in a neighborhood about each point of the starting image, wherein Θ_1, Θ_3 and Θ_4 are centered on *n,m* and Θ_2 is a

domain centered respectively on each point inside Θ_3;

– associating to each domain Θ_i, with i comprised between 1 and 4, a weight function w_i and computing a mean value μ_i of a grey levels map for domains Θ_1 and Θ_2 on the basis of said w_i;

– computing the absolute generalized central moment $e(n,m)$ on the basis of a weight function w_3 on domain Θ_3;

– splitting the absolute generalized central moment $e(n,m)$ into a positive deviation $e_p(n,m)$ and a negative deviation $e_n(n,m)$, thus creating at said discontinuity two partially overlapping bell-shaped profiles;

– convoluting the two positive $e_p(n,m)$ and negative $e_n(n,m)$ deviations with weight function w_4 on domain Θ_4;

– measuring discontinuity using said positive deviation $e_p(n,m)$ and negative deviation $e_n(n,m)$ as filters.

6. Method according to claim 6, wherein said step of measuring discontinuity is carried out by tracking of a function

$$Min(e_p(n,m), |e_n(n,m)|)$$

7. Method according to claim 6, wherein said step of measuring discontinuity is carried out through a subtraction defined as:

$$e(n,m) = e_p(n,m) - e_n(n,m)$$

8. Method according to claim 6, wherein a DoG filter (difference of Gaussian curves) is obtained using a sum of said positive $e_p(n,m)$ and negative $e_n(n,m)$ deviations of the central absolute moment.

9. Method according to claim 1, wherein said starting images are selected from the group:

– biomedical images, obtained with ultrasonic pulses, PET, SPECT, CAT, MR, etc, among which anatomical images, or images of function, obtained by means of time sequences of anatomical views of a particular zone of an organ, or

perfusion images, obtained on the same organ after treatment of the patient with substances that enhance the perfusion in the organ; images of graphs acquired by a scanner in order to convert paper graphs into digital signals.

10. Method according to claim 9 wherein, in case of images of graphs, scanned images are filtered with said absolute central moment *e(n,m)* tracking it as a bell-shaped profile whose peak is the sought digital signal, a further step being provided of computing the digital signal with a local maxima detection algorithm of standard type.

11. Method for contour tracking, according to claim 3, characterized in that at a discontinuity said generalized absolute central moment, calculated as

$$e'(n,m) = \sum_{(k,l)\in\Theta_3}\sum |\mu_1(n,m) - f(n-k,m-l)| w_3(k,l) \qquad (12)$$

is compared with a threshold value derived from said generalized absolute central moment, calculated as

$$e''(n,m) = w_4(n,m) \otimes \sum_{(k,l)\in\Theta_3}\sum |f(n,m) - f(n-k,m-l)| w_3(k,l) \qquad (13)$$

12. Apparatus for contour tracking in video images arranged as succession of photograms, characterized in that an arithmetic logic unit is used and one or more filters are used that calculate a positive deviation $e_p(n,m)$ and a negative deviation $e_n(n,m)$ of an absolute generalized central moment as defined in claim 1.

13. Apparatus according to claim 12, wherein said positive deviation $e_p(n,m)$ and said negative deviation $e_n(n,m)$ are defined as:

$$e_p(n,m) = w_4(n,m) \otimes \sum_{(k,l)\in\Theta_{3p}}\sum (\mu_1(n,m) - \mu_2(n-k,m-l)) w_3(k,l)$$

$$(7)$$

$$e_n(n,m) = w_4(n,m) \otimes \sum_{(k,l)\in\Theta_{3n}}\sum (\mu_1(n,m) - \mu_2(n-k,m-l)) w_3(k,l)$$

where domains Θ_{3p} and Θ_{3n} are defined as:

$$\Theta_{3p} = \{(k,l) \in \Theta_3 : \mu_1(n,m) > \mu_2(n-k, m-l)\}$$

(8)

$$\Theta_{3n} = \{(k,l) \in \Theta_3 : \mu_1(n,m) < \mu_2(n-k, m-l)\}$$

14. Apparatus according to claim 12 wherein said filters consist of four bidimensional convolutors and an integrator.

15. Apparatus, according to claim 13, wherein each of said bidimensional convolutors is replaced by a cascade of two monodimensional convolutors.